For more information on digital signal connections

For general information regarding digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at www.mccdaq.com/signals/signals.pdf).

Counter input

The **CTR** terminal is a 32-bit event counter that can accept frequency inputs up to 1 MHz. The internal counter increments when the TTL levels transition from low to high.

SYNC I/O

The **SYNC** terminal is a bidirectional I/O signal that can be configured as an input (default) or an output.

- Configure as an external clock input to pace the A/D conversions from an external source. The SYNC terminal supports TTL-level input signals of up to 100 kHz.
- Configure as an output that may be used to pace conversions on a second device and acquire data from 16 channels. Refer to page 14 for more information about synchronized operations.

Trigger input

The **TRIG_IN** terminal is an external digital trigger input. The trigger mode is software-selectable for edge or level sensitive. Edge sensitive mode is selectable for rising or falling. Level sensitive mode is selectable for high or low.

Reserved

The **RSVD** terminal is reserved for future use.

Ground

The analog ground (**AGND**) terminals provide a common ground for all analog channels.

The digital ground (**GND**) terminals provide a common ground for the digital, trigger, counter, and sync channels and the power terminal.

Power output

The **PC +5V** output terminal can output up to 200 mA maximum. You can use this terminal to supply power to external devices or circuitry.

Caution! The PC +5V terminal is an output. Do not connect it to an external power supply or you may damage the device and possibly the computer.

The maximum output current that can be drawn by the RedLab 1608FS-Plus is 500 mA. This maximum applies to most personal computers and self-powered USB hubs. Bus-powered hubs and notebook computers may limit the maximum available output current to 100 mA. If the current requirement of the device exceeds the current available from the computer, connect to a self-powered hub or power the computer with an external power adapter.

When running applications with the device, each DIO bit can source up to 24 mA. The total amount of current that can be sourced from the PC +5V, SYNC, and digital outputs is 200 mA max.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Resolution is often used incorrectly to quantify the performance of a measurement product. While "16-bits" or "1 part in 65,536" does indicate what can be resolved, it provides little insight into the quality, or accuracy, of an absolute measurement. Accuracy specifications describe the actual measurement achievable with a RedLab 1608FS-Plus. Accuracy specifications are listed Seite 16.

There are three types of errors which affect the accuracy of a measurement system:

- offset

- gain
- nonlinearity

The primary error sources in a RedLab 1608FS-Plus are offset and gain. Nonlinearity is small, and is not significant as an error source with respect to offset and gain.

Figure 7 shows an ideal, error-free transfer function. The typical calibrated accuracy of a RedLab 1608FS-Plus is range-dependent. We use a ±10 V range as an example of what you can expect when performing a measurement in this range.

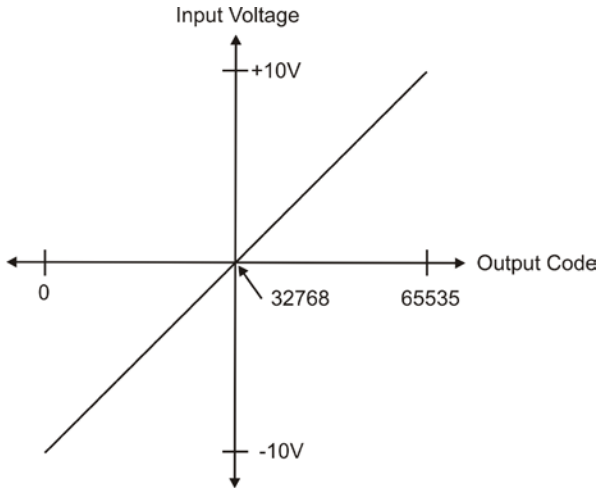

Figure 7. Ideal ADC transfer function

The offset error is measured at mid-scale. Ideally, a zero volt input should produce an output code of 32,768. Any deviation from this is an offset error. Figure 8 shows the transfer function with an offset error. The typical offset error specification for a RedLab 1608FS-Plus on the ±10 V range is ±1.66 mV. Offset error affects all codes equally by shifting the entire transfer function up or down along the input voltage axis.

The accuracy plots in Figure 8 are drawn for clarity and are not drawn to scale.

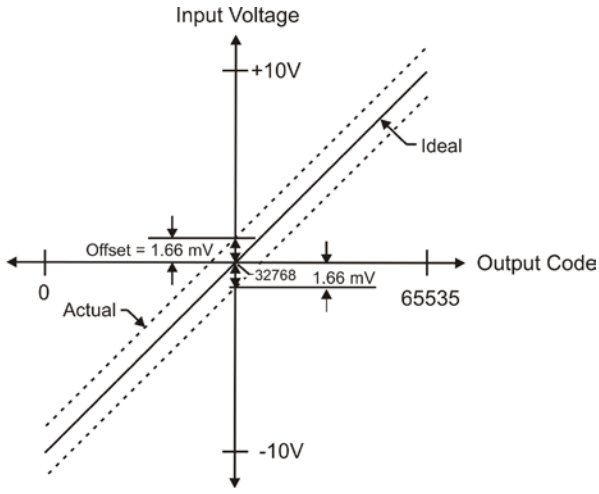

Figure 8. ADC transfer function with offset error

Gain error is a change in the slope of the transfer function from the ideal, and is typically expressed as a percentage of full-scale. Figure 9 shows the RedLab 1608FS-Plustransfer function with gain error. Gain error is easily converted to voltage by multiplying the full-scale input (±10 V) by the error.

The accuracy plots in Figure 9 are drawn for clarity and are not drawn to scale.

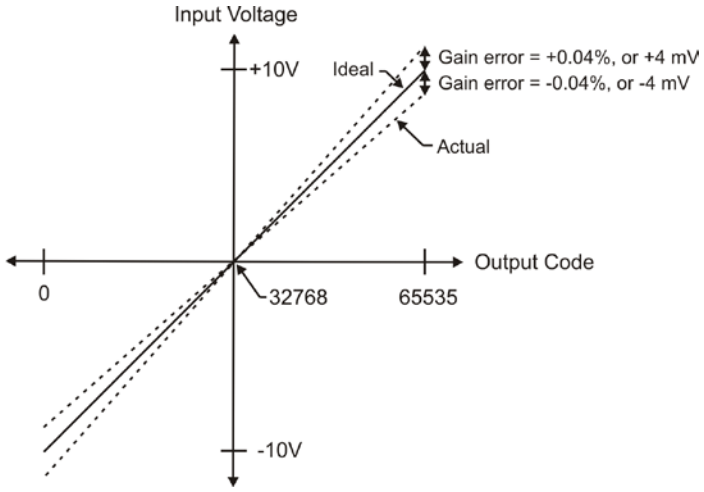

Figure 9. ADC Transfer function with gain error

For example, a RedLab 1608FS-Plus exhibits a typical calibrated gain error of ±0.04% on all ranges. For the ±10 V range, this would yield 10 V × ±0.0002 = ±4 mV. This means that at full scale, neglecting the effect of offset for the moment, the measurement would be within 4 mV of the actual value. Note that gain error is expressed as a ratio. Values near ±FS (±10 V) are more affected from an absolute voltage standpoint than are values near mid-scale, which see little or no voltage error.

Combining these two error sources in Figure 10, we have a plot of the error band at ±full scale (±10 V). This plot is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 10 are drawn for clarity and are not drawn to scale.

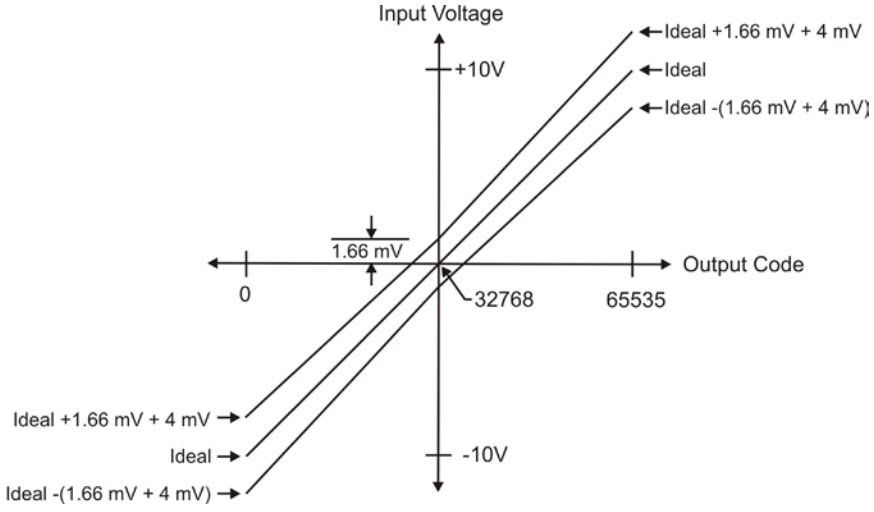

Figure 10. Error band plot

Synchronized operations

You can connect the SYNC pin of multiple devices together in a master/slave configuration and acquire data from the analog inputs of all devices using one clock.

When the SYNC pin is configured as an output, the internal A/D pacer clock signal is sent to the screw terminal. You can output the clock to the SYNC pin of another device that is configured for A/D pacer input.

Mechanical drawings

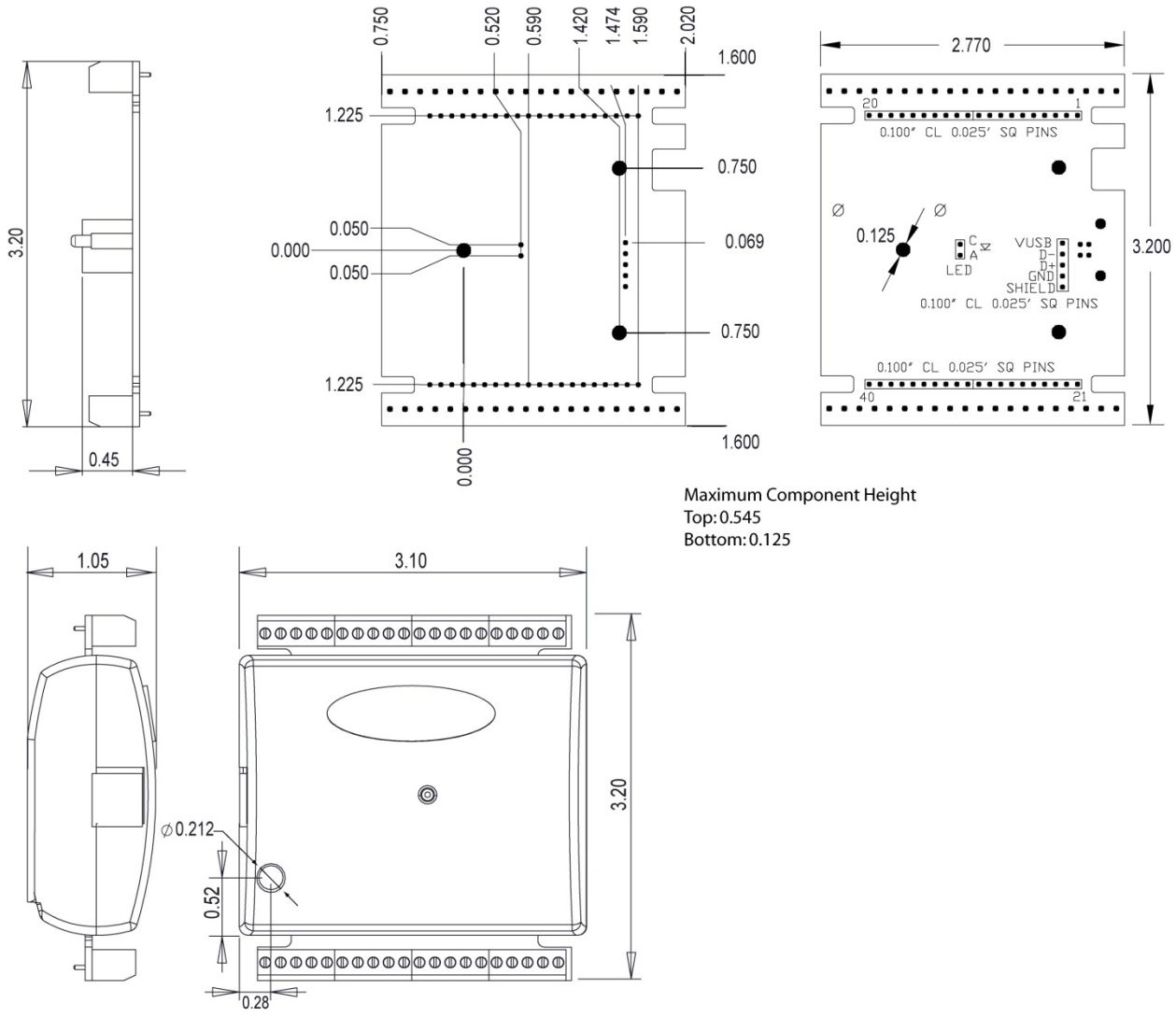

Figure 11. RedLab 1608FS-Plus circuit board (top) and enclosure dimensions

Specifications

All specifications are subject to change without notice.
Typical for 25°C unless otherwise specified.
Specifications in *italic* text are guaranteed by design.

Analog input

Table 1. General analog input specifications

Parameter	Condition	Specification
A/D converter type		16-bit successive approximation type
Number of channels		8 single-ended
Input configuration		Individual A/D per channel
Sampling method		Simultaneous
Absolute maximum input voltage	*CHx IN relative to GND*	*±15 V max*
Input impedance		100 MΩ min
Input ranges	Software-selectable per channel	±10 V, ±5 V, ±2 V, ±1 V
Sampling rate	Hardware paced	0.01 S/s to 100 kS/s, software-selectable
Throughput	Software paced	500 S/s all channels
	Hardware paced (Note 1)	(400 kS/s) / (# of channels) max, 100 kS/s max for any channel
	BURSTIO ≤ 32,768 total samples (uses onboard FIFO)	(800 kS/s) / (# of channels) max, 100 kS/s max for any channel
Gain queue		Software configurable. Up to eight elements – one gain element per unique, ordered channel.
Resolution		16 bits
No missing codes		*16 bits*
Crosstalk	Signal DC to 25 kHz	–80 dB
Trigger source	Software-selectable	External digital: TRIG_IN

Note 1: Maximum throughput when scanning in hardware paced mode is machine dependent.

Accuracy

Analog input DC voltage measurement accuracy

Table 2. Calibrated absolute accuracy

Range	Accuracy (mV)
±10 V	5.66
±5 V	2.98
±2 V	1.31
±1 V	0.68

Table 3. Accuracy components - All values are (±)

Range	Gain error (% of Reading)	Gain error at FS (mV)	Offset (mV)
±10 V	0.04	4.00	1.66
±5 V	0.04	2.00	0.98
±2 V	0.04	0.80	0.51
±1 V	0.04	0.40	0.28

Noise performance

Table 4. Noise performance

Range	Typical counts	LSBrms
±10 V	10	1.52
±5 V	10	1.52
±2 V	11	1.67
±1 V	14	2.12

Table 4 summarizes the noise performance for the RedLab 1608FS-Plus. Noise distribution is determined by gathering 50 K samples with inputs tied to ground at the user connector. Samples are gathered at the maximum specified sampling rate of 100 kS/s.

Digital input/output

Table 5. Digital I/O specifications

Parameter	Specification
Digital type	5V TTL
Number of I/O	8 (DIO0 through DIO7)
Configuration	Independently configured for input or output
Pull-up/pull-down configuration	All pins pulled up to 5V via 47 K resistors (default). May be changed to pull-down using an internal jumper.
Input high voltage threshold	2.0 V min
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	0.8 V max
Input low voltage limit	–0.5 V absolute min 0 V recommended min
Output high voltage	4.4 V min (IOH = –50 µA) 3.76 V min (IOH = –24 mA)
Output low voltage	0.1 V max (IOL = 50 µA) 0.44 V max (IOL = 24 mA)
Power on and reset state	Input

External trigger

Table 6. External trigger specifications

Parameter	Condition	Specification
Trigger source	External digital	TRIG_IN
Trigger mode	Software-selectable	Edge or level sensitive: user configurable for CMOS compatible rising or falling edge, high or low level.
Trigger latency		2 µs + 1 pacer clock cycle max
Trigger pulse width		1µs min
Input type		Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis		1.01 V typ 0.6 V min 1.5 V max
Input high voltage threshold		2.43 V typ 1.9 V min 3.1V max
Input high voltage limit		5.5 V absolute max
Input low voltage threshold		1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit		-0.5 V absolute min 0 V recommended min

External clock input/output

Table 7. External clock I/O specifications

Parameter	Condition	Specification
Pin name		SYNC
Pin type		Bidirectional
Direction, software-selectable	Input	Receives A/D pacer clock from external source
	Output	Outputs internal A/D pacer clock
Input clock rate		100 kHz, max
Clock pulse width	Input	1 µs min
	Output	4 µs min
Input clock mode		Edge sensitive, rising
Input type		Schmitt trigger, 47 kΩ pull-down to ground
Schmitt trigger hysteresis		1.01 V typ 0.6 V min 1.5 V max
Input high voltage threshold		2.43 V typ 1.9 V min 3.1V max
Input high voltage limit		5.5 V absolute max
Input low voltage threshold		1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit		-0.5 V absolute min 0 V recommended min
Output high voltage		4.4 V min (IOH = –50 µA) 3.80 V min (IOH = –8 mA)
Output low voltage		0.1 V max (IOL = 50 µA) 0.44 V max (IOL = 8 mA)

Counter section

Table 8. Counter specifications

Parameter	Specification
Pin name	CTR
Counter type	Event counter
Number of channels	1
Input type	Schmitt trigger, 47 kΩ pull-down to ground
Input source	CTR screw terminal
Resolution	32 bits
Schmitt trigger hysteresis	1.01 V typ 0.6 V min 1.5 V max
Input high voltage threshold	2.43 V typ 1.9 V min 3.1V max
Input high voltage limit	5.5 V absolute max
Input low voltage threshold	1.42 V typ 1.0 V min 2.0 V max
Input low voltage limit	-0.5 V absolute min 0 V recommended min
Input frequency	1 MHz max
High pulse width	*500 ns min*
Low pulse width	*500 ns min*

Memory

Table 9. Memory specifications

Parameter	Specification
Data FIFO	32,768 samples, 65,536 bytes
EEPROM	2,048 bytes (768 bytes calibration, 256 bytes user, 1,024 bytes DAQFlex)

Microcontroller

Table 10. Microcontroller specifications

Parameter	Specification
Type	*High performance 32-bit RISC microcontroller*

Power

Table 11. Power specifications

Parameter	Condition	Specification
Supply current	USB enumeration	< 100 mA
Supply current	Including DIO and SYNC output loading	< 500 mA
+5V power available (Note 2)	Connected to externally-powered root port hub or a self-powered hub	4.5 V min, 5.25 V max
Output current (Note 3)		200 mA max

Note 2: "Self-powered hub" refers to a USB hub with an external power supply. Self-powered hubs allow a connected USB device to draw up to 500 mA. "Root port hubs" reside in the PC USB host Controller. The USB port(s) on your PC are root port hubs. All externally-powered root port hubs, such as a desktop PC, provide up to 500 mA of current for a USB device. Battery-powered root port hubs provide 100 mA or 500 mA, depending upon the manufacturer. A laptop PC that is not connected to an external power adapter is an example of a battery-powered root port hub. If your laptop PC is constrained to the 100 mA maximum, you need to purchase a self-powered hub.

Note 3: Output current is the total amount of current that can be sourced from the PC +5V, SYNC, and digital outputs.

General

Table 12. General specifications

Parameter	Specification
Device type	USB 2.0 (full-speed)
Device compatibility	USB 1.1, USB 2.0

Environmental

Table 13. Environmental specifications

Parameter	Specification
Operating temperature range	0 °C to 70 °C
Storage temperature range	–40 °C to 70 °C
Humidity	0% to 90% non-condensing

Mechanical

Table 14. Mechanical specifications

Parameter	Specification
Dimensions (L × W × H)	79 × 82 × 27 mm (3.10 × 3.20 × 1.05 in.)
USB cable length	3 m (9.84 ft) max
User connection length	3 m (9.84 ft) max

Screw terminal connector and pinout

Table 15. Connector specifications

Parameter	Specification
Connector type	Screw terminal
Wire gauge range	16 AWG to 30 AWG

Table 16. Connector pinout

Pin	Signal Name	Pin	Signal Name
1	CH0 IN	21	DIO0
2	AGND	22	GND
3	CH1 IN	23	DIO1
4	AGND	24	GND
5	CH2 IN	25	DIO2
6	AGND	26	GND
7	CH3 IN	27	DIO3
8	AGND	28	GND
9	CH4 IN	29	DIO4
10	AGND	30	GND
11	CH5 IN	31	DIO5
12	AGND	32	GND
13	CH6 IN	33	DIO6
14	AGND	34	GND
15	CH7 IN	35	DIO7
16	AGND	36	SYNC
17	RSVD	37	TRIG_IN
18	AGND	38	CTR
19	AGND	39	PC +5V
20	AGND	40	GND

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